Spring 2020

PHYS 641-102: Statistical Mechanics (Revised for Remote Learning)

Junjie Yang

Physics 641 Syllabus Spring 2020

Class meeting: Faculty Memorial Hall 203, Mondays, 6:00pm-8:50 pm
Jan 21, 2020 – March 9, 2020
March 23, 2020 – May 14, 2020: online course using Webex.

Instructor	Email	Office Location & Hours
Prof. Junjie Yang	jyang@njit.edu	423C, Tiernan Hall, Mondays 11 am – 12 pm

General Information

Descriptions

This course provides an introduction to statistical mechanics, including the thermodynamics, classical and quantum statistical mechanics. The main goal of this course is to help students understand the key concepts of statistical physics. The course objective will be accomplished through lecture and problem solving. The class will also follow a question and answer approach, hopefully this will promote creative thinking. Students are encouraged to read the materials in textbooks before coming to class.
The Course Schedule below lists topics covered. Professors will make an effort to help the students succeed by using active learning. See: https://physics.njit.edu/

Learning Expectations, Goals and Outcomes

1) Demonstrate a conceptual understanding of terms such as equipartition theorem, entropy, fluctuations, heat capacities, Gibbs free energy, Bose-Einstein distributions, Fermi-Dirac distributions and phase transitions and the ability to use them in the context of physical systems.
2) Utilize the laws of thermodynamics and statistical mechanics (in particular, ensembles and partition functions) to analytically describe various thermodynamics systems and processes.
3) To be able to solve problems for equilibrium properties of simple quantum systems.

Professors and students will measure Outcomes by the performance on assessments as listed below under final grade calculations.

Course Materials

Text (optional)

Keith Stowe, *An Introduction to Thermodynamics and Statistical Mechanics,* Cambridge University Press, 2007.

Mehran Kardar, *Statistical Physics of Particles*, Hardback: ISBN-10 0-521-87342-8, or ISBN-13 978-0-521-87342-0, eBook (EBL): ISBN-13 978-0-511-28912-5, or ISBN-10 0-511-28912-X

Introduction to Modern Statistical Mechanics by David Chandler

Statistical Mechanics (2nd Edition) by Kerson Huang, John Wiley.

*Canvas is required for this course and supplements the text. Some quizzes may be online via Canvas> Assignments, information and grades will be on Canvas.

Final Grade Calculation:

The Weights for parts of the course are as follows:	
Quizzes and Class Participation	10%
Homework	30%
Exams (Mid Exam 1 = 15%, Mid Exam 2 = 15% Final = 30%)	60%
	100%

In-class Quizzes: (10 % of grade) Students are expected to participate regularly in class discussions by asking and answering questions, volunteering to solve problems, and working actively with others during in-class group assignments. When all students participate in each class, it creates an active learning environment that will help you understand the materials and be more successful in the class.

Homework: (30% of grade) Half of the Homework questions are closely related to previous exams, so the understanding you gain from doing them is an added benefit. The homework is the greatest help for yourself if you figure it out by yourself.

Exams: (60% of grade) The mid exams before the Final is scheduled on dates listed on Page 4. The amount of new material covered determines the exam weight, unless otherwise specified. The professors will help you as much as possible by covering all concepts and all settings of exam questions in class and with special review sessions. Make-ups for missed exams are only with advance permission from both your instructor and the Dean of Students. The Final will emphasize the weeks of work after mid exams, plus an overview of the whole course. The Final exam is not scheduled yet.

The conversion of numerical to letter grades is as follows: > 85% A; >80 to 85 B+; >70 to 80 B; >65 to 70 C+; >55 to 65 C; >50 to 55 D and <50 F

If you need any extra information about class, quiz or exam questions, ask Prof. Junjie Yang. After the Final exam, the course ends, and questions and grades are not open to discussion.

Course Policies

Honor Code: The NJIT Student Council dictates: “NJIT has a zero-tolerance policy for cheating of any kind and for student behavior that disrupts learning by others.” The NJIT Student Senate has requested a zero-tolerance policy for cheating of any kind and for behavior that disrupts learning. The Senate wants fairness for all students. The Dean of Students determines punishments and requires professors to report any incidents. The penalties include failure in the course plus disciplinary probation up to expulsion from NJIT. Avoid situations where anyone could misinterpret your behavior as dishonorable. Students are required to agree to the NJIT Honor Code on each exam, assignment, quiz, etc. for the course. Turn off all cellular phones,

wireless devices, computers, and messaging devices of all kinds during classes and exams. Please do not eat, drink, or create noise in class that interferes with the work of other students or instructors.

Missed quizzes and exams: There are *no make-ups* for in-class activities. If you miss a quiz, you will receive a grade of zero. If you miss an exam and the make-up time, you will receive a score of zero for that Exam. That score will be included in the calculation of your final grade. If you miss two exams, you will automatically fail the course. To get credit for an exam, you must notify your instructor PRIOR TO the exam you will miss, as above. In order to be qualified to receive a "make-up" exam score (a very rare occurrence), the student should present documentation for not being able to take the test as scheduled. As is the standard policy of NJIT, this documentation should be presented to the student's to the **Dean of Students - (973) 596-3466, Room 255 Campus Center**. BOTH the instructor and Dean of Students must concur in permitting a "make-up" exam. Students who miss exams that do not present documentation within 7 days of the exam will receive a score of zero for the exam.

In the event that the above qualification is met, a separate make-up test for the missed quiz will not be offered. Instead, the portion of the final exam relevant to the contents of the missed test will be considered for giving a grade for the missed test. The instructor will evaluate the final exam questions from those chapters and normalize this portion of the student's grade for the missed quiz.

Late work: Homework is due by times and dates indicated in the homework. You cannot make up a Quiz that you miss.

Class attendance: The NJIT attendance policy is the following: "It is expected that students will attend all classes. Your teacher will take attendance at all classes and exams. More than 3 unexcused absences (in total) are excessive." If you have excusable absences, contact your instructor or the Dean of Students - (973) 596-3466, Room 255 Campus Center. If you have to miss class, let your professor know.

Withdrawal: If you must withdraw from the course, do it officially through the Registrar, otherwise your course grade will be F.

Electronics: Cell phones and laptops must be off during classes and exams, except as indicated by the instructor.

Course Schedule

Classes start Monday Jan 21;

We recommend that you read all chapters in our textbook as indicated below before class. Professors may give quizzes both before and after they cover material in class. The combination of reading and discussion helps learning.

Week 1 to 4: Introduction:
Mean values, Probabilities, Fluctuations and Gaussian Distribution
Equilibrium and Density of States
Internal Energy, Degrees of Freedom and Equipartition
First Law, Entropy and Second Law,
Temperature, Heat Capacities and Third Law
Natural and Imposed Constrains,

Gas, Liquid and Solids, Special processes,
Week 5: Review and Exam 1.

Week 6 to 8: Classical Statistics
Micro-canonical ensemble,
Canonical ensembles,
Grand canonical ensemble, occupation number
Gibbs ensemble,
Partition Functions,
Maxwell-Boltzmann Statistics and distribution.

Week 9: Review and Exam 2.

Week 10 to 15: Quantum Statistics
Bose-Einstein statistics, Fermi statistics and their application
Blackbody Radiation: Photons; Solids: Phonons
Phase Transitions and Interacting Gas: classical and quantum.
Optional: Kinetic theory, transport phenomena and magnetism.

Week 16: Final Exam

Exams:

Mid exams:

1. Feb/17/2020, Weeks 1-4
2. March/23/2020, Weeks 6-8, take-home exam

Final exam: Exam Comprehensive Final Exam will be given during Final Exam Period; Content: some coverage of Weeks 1-9; more coverage of Weeks 10-15.

Additional Information and Resources

Resources for NJIT Students

Academic Advising Success Center "...assist in the advisement of students who are undecided in their major, transitioning into another major at NJIT, and those students who need additional support to graduate successfully and in a timely manner."

Academic Support and Student Affairs "From questions about becoming a student at NJIT – to student engagement – to searching for information on career development, the Division of Academic Support and Student Affairs Staff is here to help."

Additional Tutoring Centers Physics Learning Center; Math Learning Center; Chemistry Learning Center; The Writing Center; ECE Study Groups Center for Counseling and Psychological Services "The NJIT Center for Counseling and Psychological Services (C-CAPS) is committed to assisting students in the achievement of their academic goals as well as benefiting from their personal experience on campus. College life can be personally challenging and stressful at times. We believe that the educational process is an important component of the development of the individual as a whole person. Our goal is to optimize the college experience and improve the quality of the lives of our students by promoting their mental health and facilitating students' personal, academic and

professional growth."

Department of Public Safety "The Department of Public Safety, conveniently located at 154 Summit St. on the first level of the Parking Deck, provides police protection 24 hours a day, 7 days a week."

Disability Support Services "If you need accommodations due to a disability please contact Chantonette Lyles, Associate Director of Disability Support Services, Fenster Hall Room 260 to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required."

Health Services "To ensure the good health of our students, the NJIT Student Health Service provides quality healthcare to all eligible NJIT registered students."

IST Service Desk "The IST Service Desk is the central hub for computing information and first point of contact for getting help and reporting issues related to computing technology at NJIT. There is much technology here at NJIT, and many ways to find information or get help with it." The Learning Center "Our mission is to assist students both in the classroom and beyond by providing tutorial services, academic coaching, academic and personal enrichment workshops and staff and peer support so students can meet the demands of their coursework and are prepared for life after graduation."

NJIT/Rutgers Shuttle Service "The shuttle bus is operated jointly with Rutgers-Newark and provides transportation for the University community between the two campuses, major mass transit systems, and Harrison and Kearny. As a courtesy, shuttle service is free to the Rutgers/NJIT community who present identification."

Office of Global Initiatives Resources for international students and study abroad programs. Robert W. Van Houten Library "The Van Houten Library offers electronic and print resources essential to the mission of New Jersey's science and technology university, including a core collection of academic books, databases, and journals, as well as research and consultation services."

Student Financial Aid Services "Student Financial Aid Services (SFAS) at NJIT is committed to providing you with every opportunity to obtain funding to support your educational costs at NJIT."

Spring 2020 Academic Calendar

January	20	Monday	Martin Luther King, Jr. Day
January	21	Tuesday	First Day of Classes
January	25	Saturday	Saturday Classes Begin
January	31	Friday	Last Day to Add/Drop a Class
January	31	Friday	Last Day for 100% Refund, Full or Partial Withdrawal
February	1	Saturday	W Grades Posted for Course Withdrawals

February	3	Monday	Last Day for 90% Refund, Full or Partial Withdrawal - No Refund for Partial Withdrawal after this date
February	17	Monday	Last Day for 50% Refund, Full Withdrawal
March	9	Monday	Last Day for 25% Refund, Full Withdrawal
March	15	Sunday	Spring Recess Begins - No Classes Scheduled - University Open
March	22	Sunday	Spring Recess Ends
April	6	Monday	Last Day to Withdraw
April	10	Friday	Good Friday - No Classes Scheduled - University Closed
May	5	Tuesday	Friday Classes Meet
May	5	Tuesday	Last Day of Classes
May	6	Wednesday	Reading Day 1
May	7	Thursday	Reading Day 2
May	8	Friday	Final Exams Begin
May	14	Thursday	Final Exams End
May	16	Saturday	Final Grades Due